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(71) Anmelder *(für alle Bestimmungsstaaten ausser US)*: DR. ING. REINHOLD WIECHERN MESSTECHNIK UND AUTOMATISIERUNG GMBH [DE/DE]; Wittenborner Strasse 22, D-23812 Wahlstedt (DE).

(72) Erfinder; und
(75) Erfinder/Anmelder *(nur für US)*: WIECHERN, Reinhold [DE/DE]; Wittenborner Strasse 22, D-23812 Wahlstedt (DE).

(74) Anwalt: HUBER, Arnulf; Uexküll & Stolberg, Beselerstrasse 4, D-22607 Hamburg (DE).

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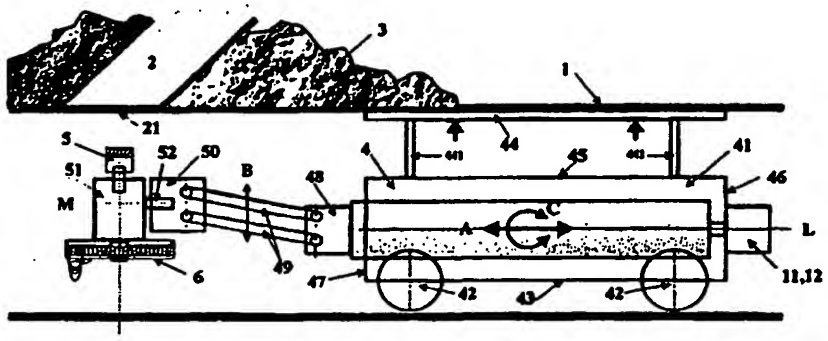
(54) Title: PIPING MILLING ROBOTIC DEVICE

(54) Bezeichnung: KANAL-FRÄSROBOTER

(57) Abstract



The invention relates to a piping robotic device in the form of an elongate conveyor slide (41), wheels (42) being mounted on the lower surface (43) thereof, and the opposite upper surface (45) thereof being provided with an extendable pressure cushion (44) for clamping of the conveyor slide (41) in a sewage pipe (1). There are hydraulic and/or pneumatic and electrical control and supply lines attached to the rear side (46) of said conveyor slide (41), and a movable cylinder (48) rotatable perpendicular to the longitudinal axis (L) of the conveyor slide (41) and displaceable in a linear manner in the longitudinal axis (L) of said slide (41). A parallel rod assembly (49) is articulated to the front side of the movable cylinder and has a tool holder (50) into which a drive holder (51) with a milling head (5) is inserted which can be rotated in a plane about 180° by way of a pin (52) in the tool holder (50). Said plane is perpendicular to the longitudinal axis of the conveyor slide (41) and consequently also extends in the form of a radial plane perpendicular to the direction of movement of the conveyor slide (41) in the sewage pipe (1). For metrological detection of the space co-ordinates of the non-visible house connections (2), which co-ordinates are required for free milling, a combination sensor (6) is also staggered by 180° on the drive holder (51) in the plane of rotation of the milling head (5) and consequently arranged diametrically in relation to said milling head (5). The combination sensor (6) has a capactive sensor (61) and an ultra-sound sensor (62). To determine the position of the combination sensor (6), a combined path and angle measuring system (12) with a signal evaluation circuit (8) is coupled to the movable cylinder (48).

The invention concerns a channel milling robot in accordance with generic term of the patent claim 1.

From Fig. 8 the EP 0,326,412 A1 already a channel milling robot is well-known, which exhibits the characteristics of the generic term of the patent claim 1. To frontend a transportation carriage is attached a tool holder, which can in this way be turned around the longitudinal axis of the transportation carriage and with a turn around 180 DEG a blade antenna and afterwards a milling tool can bring into the same position. The blade antenna serves for it, certain markers on zufinden, which were inserted before lining the pipe which can be repaired into the branching annexes by plugs out for example polystyrene. These position markers mark exactly the center of the annexes. If their situation were found by the blade antenna of the milling robot, the tool holder 180 DEG and the milling tool in adjustment with the position marker gebracht.In this position can be free-milled the annexe, whereby the plug with the position marker is destroyed and is lost. A disadvantage of this well-known equipment exists to be able to be free-milled therefore therein that in a first work procedure first the annexes will provide with position marks must, in a second work procedure the lining with a so-called Inliner made and in a third Arbeitssch the annexes is only visited and following. From the DE 40 24 926 A1 a similar device is well-known, with which a similar procedure is accomplished as with the EP 0,326,412 A1, i.e. the annexes are provided in a first work procedure with cover caps, into which as a permanent bar magnet of trained signal generators is integrated. The longitudinal axis of the permanent bar magnet coincides thereby with the axle of the annexe. From the DE 195 21 895 a procedure for examining a covered range of a sewer pipe or a sewer pipe the surrounding range on defective equipment is well-known using a transmitter/receiver system, which is led on a car by the sewer pipe. The transmitter/receiver system is turned thereby continuously around an axle pointing into the direction of extending the sewer pipe and sends continuously electromagnetic energy in the direction of the wall of the sewer pipe. The microwaves used thereby have a frequency within the range between 5 and 60 GHz. From the DE 43 23 182 c1 a datum locator is well-known for branch line connections in pipes, which exhibits in the pipe movably a chassis, a sensor head and a drive device, whereby the sensor head is swivelling around an axle parallel to the tubing axle with the help of the drive device. The sensor head is trained cylindrical and exhibits on its extent a majority of inductive transducers, which are arranged with gap distance to the tube sheet.

From 42 08 863 A1 a device is sewer-well-known of the DE to the material investigation by walls one, with which at self-propelled transport equipment a signal generator and a receiver are arranged. The signal generator is a microwave generator, which produces impulses, which are directed toward the wall of the sewer by a control unit. The reflection signal received thereby is caught and evaluated in the receiver. It is possible to attain statements about the internal condition of the wall. Also cavities as well as Hinterspuelungen can be detected, but not measured accurately.

Furthermore it is already so-called "KA-WIDTH unit a Cutter" well-known, which is manufactured by the company of KA-WIDTH unit system AG, glue brook route 38, CH-8041 Zurich and driven out in Germany for example by the channel technology Kunz GmbH, Hofmann route 52, D-81379 Munich. The well-known KA-WIDTH

unit Cutter is a channel Fraesrobo<DP N=3>ter, which exhibits an oblong, essentially quaderfoermigen transportation carriage with four wheels. To the rear end of D of transportation carriage hydraulic, pneumatic and/or electrical control lines are attached. To frontend is installed a milling head over a swivelling neck. In addition a television camera is attached at the front end, which examines the respective work area KA-WIDTH unit of the Cutters. The transportation carriage w furthermore a pressure cushion up, which are squeezed out over stamps from the carriage body and which transportation carriage in the sewer within the range of working premises determines, at which the milling head an opening for an annexe to manufacture is. This is in particular then necessarily, if defective sewers were lined first in the Inliner procedure with a new pipe wall, with which first no openings for annexes are present, but to be only later furnished must. One proceeds thereby so that first the transportation carriage is moved by not lined the sewer the yet and with the help of the television camera, whose pictures will transfer a set up to a monitor outside of the sewer, which annexes searched werden.Sobald an annexe is discovered to become the coordinates held, in order to find this place after drawing in the interior pipe again. It is obvious that this procedure does not work reliably and very exactly particularly, so that the fraesarbeiten not rarely result in an opening, which is more or less strongly transferred opposite the annexe to open an annexe. Task of the invention is it to improve the channel milling robot of the kind initially specified going by that on the one hand no special position markers for annexes to be set to have and that on the other hand nevertheless found after drawing in an interior pipe ("Inliner") into a sewer the annexes reliable and in correct adjustment in addition the openings from the interior pipe to be worked out to be able. For the solution the characteristics of the patent claim 1 serve this task.

According to invention it is reached by the measuring adapter that after a rough positioning of the transportation carriage due to the measurements taken place before drawing in the interior pipe the situation of the annexe covered by the interior pipe can be determined reliably, according to which the combination sensor according to invention is swivelled around 180 DEG in one level, which stands orthogonal to the axle center of the sewer, so that the milling head is moved into the same position, in which the scanning combination sensor was before. The plane of rotation of the combination sensor is thus one radial level of the sewer. The combination sensor according to invention consists of an ultrasonic sensor, with which a same distance to the inner wall of the sewer can be always kept, and from a capacitive sensor surrounding the ultrasonic sensor, with which it can be determined whether behind the wall of the sewer soil or an opening for an annexe lies. The evaluation of the signals effected in actually well-known way by means of computer, produced by the combination sensor, which exhibits appropriately also a monitor for the announcement of the data and/or spatial conditions in the sewer and/or the brought in Inliner pipe. The invention is more near described now on the basis a remark example; show: Fig. 1 a schematically represented channel milling robot in working position; Fig. 2 a cutout from the measuring head of the milling robot from Fig. 1; and Fig. 3 schematic representations of the function of the milling robot Fig. 1 shows a cutout from a reorganization pipe 1 of a sewer, from which an annexe 2 branches in form of an actually well-known piping from stoneware or plastic. The environment of the reorganization pipe is suggested by soil 3. Into the reorganization pipe 1 a transportation unit 4 is brought in, which is displaceable by wheels 42 in longitudinal direction of the reorganization pipe 1 and thus toward the arrow A. The movement of

the transportation unit 4 in the reorganization pipe 1 is steered from the outside lines over not represented. It is well-known to use for the monitoring of the movement of the transportation unit 4 a television camera which is not shown for reasons of clarity.

The transportation unit 4 essentially covers a transportation carriage 41 with a lower surface 43, a top side 45, a back 46 as well as a front 47. Usually the transportation carriage 41 has the form of an oblong prism, at whose back 46 connections for hydraulic and/or pneumatic lines as well as electrical tax and signal lines are intended. At or on the top side 45 of the transportation carriage 41 a pressure cushion 44 is arranged, which is extendable by telescopic cylinders 441, in order to push away at the inside of the reorganization pipe 1 and to clamp with it the transportation unit 4 locally in the reorganization pipe 1. The telescopic cylinders 441 can be driven out in actually well-known way, for example by hydraulic fluid or by compressed air. In the transportation carriage 41 a driving out cylinder 48 is intended, which stands out from the front 47 of the transportation carriage 41 and which in the longitudinal axis L of the transportation unit 4 toward the double arrow A back and forth movably and in addition around the longitudinal axis L toward C is swivelling. The movement of the driving out cylinder 48 is determined by a measuring system 12 appropriate at the back 46 of the transportation unit 4 and steered via control drives 11, those in Fig. 3 is recognizable. At the front of the driving out cylinder 48 a parallel linkage 49 is linked, steered permitted by the transportation carriage 41 a movement in one level, which is suggested by the double arrow B. The parallel linkage 49 is coupled with its front hinge points with a tool holder 50, whereby the tool holder 50 can be raised and/or lowered toward the arrow B. Via the use of a parallel linkage 49 the movement of the tool holder 50 always takes place in one level, those in Fig. 1 with the indication level collapses. The tool holder 50 carries a drive owner 51, which carries a milling head 5 at a side and at the other side a combination sensor 6 at its front end. The drive owner 51 is coupled with the tool holder 50 over a tap 52, which is held actually well-known way in the tool holder 50.

Since the combination sensor 6 diametrically opposite to the milling head 5 at the drive owner 51 is installed, a turn of the driving out cylinder brings around 180 DEG the milling head 5 to 48 accurately into the position, in which the combination sensor 6 was before. The same applies also in reverse. In this way it is possible to determine and swivel afterwards after determination of the exact position of the annexe 2 the milling head 5 into the measuring position first with the combination sensor 6 the situation of the annexe 2, which becomes then a working position for the milling head 5 of the transportation unit 4. For this first the tool holder 50 by the parallel linkage 49 is moved toward B into the longitudinal axis L of the transportation carriage 41; afterwards the driving out cylinder 48 of one of the control drives 11 around the longitudinal axis L toward the arrow C turn afterwards is raised the tool holder 50 again toward the arrow B and thus bound the reorganization pipe 1 too moved. Fig. 2 shows details of the combination sensor according to invention 6 in schematic, increased representation. The combination sensor 6 is formed by a capacitive sensor 61 and an ultrasonic sensor 62.

The capacitive sensor 61 consists of three electrodes 611, 612 and 613, which are concentrically around the ultrasonic sensor 62 arranged as ring electrodes. Thus the ultrasonic sensor 62 lies in the range of the center of the three concentric electrodes 611-613. The outside electrode 613 of the capacitive sensor 61 is grounded, while to

the middle electrode 612 and the internal electrode equal to 611 two, high frequency tensions by few volts to be usually supplied. The internal electrode 611 and the middle electrode 612 are connected for the one voltage difference on the lines 711 and 712 by lines 711 and 712 with a measuring amplifier 7, measure and these as signal U(A, C) spend. If the dielectric within the range of the lines of flux of of the capacitive does not change sensor 61, thus if the field lines suggested in the design always run by soil 3, then spends the measuring amplifier 7 the same difference signal. If the capacitive sensor 61 comes however into the range of an annexe 2, with which the soil 3 is replaced by air or water, then the dielectric changes within this range and it to a disturbance of the lines of flux will come, which another difference signal on the lines 711, 712 entails, which is recognized by the measuring amplifier 7 and processed in a computer 9. In this way it can be determined contactlessly whether behind the wall of the reorganization pipe 1 an annexe 2 or soil 3 lies. The measured values result in in the long run a curve 91 indicated by the monitor of the computer 9.

Since the output voltage U(A, C) both by the dielectric of the through-radiated material and by the distance of the capacitive sensor 61 to the inner wall of the reorganization pipe 1, the capacitive sensor 61 during the measurement in constant distance r is affected must always be to the reorganization pipe 1, what is reached by the fact that the ultrasonic sensor 62 measures the distance r and keeps it constant over an actuator 65. For this the ultrasonic sensor 62 coupled with a measuring amplifier 63 is, whose output signal is put to a comparator circuit 69, which compares the spacer signal Rist with the given value rsoll and heads for over a driver 64 the actuator 65, which readjusts the distance on r = const, by the parallel linkage 49 in Fig. 1 toward the arrow B is raised or lowered.

Fig. a stirnansicht of the channel milling robot shows 3 in schematic representation, whereby in the left part the measuring position is represented and in the right part the working position for working an opening out from the reorganization pipe 1 in the range of an annexe 2. One recognizes that the combination sensor 6 is directed first toward the inner wall of the reorganization pipe 1, to which the driving out cylinder 48 is turned steered by the control drive 11 around the longitudinal axis L of the transportation unit 4. Same parts are in all other respects provided with same reference symbols in all figures. In addition one sees, how the combination sensor 6 can be moved by raising and/or lowering the parallel linkage 49 toward the arrow B and so that a constant distance to the inner wall of the reorganization pipe 1 is kept. By tricks of the driving out cylinder 48 around the longitudinal axis L toward the arrow C the combination sensor 6 will become along the inner wall of the reorganization pipe swivelled and the tension signals taken up thereby the measuring amplifier 7 transmitted. As previously mentioned, the output signals U(A, are transferred C) of the measuring amplifier 7 to the computer 9 which indicates a penetration curve to 91 of the covered annexe opening. Furthermore to the computer 9 the gating circuit 8 is attached. The penetration curve 91 is stored in the computer 9 and consulted for the control of the control drive 11, which brings the milling head to 5 into the position of the combination sensor 6, after the entire course of the curve of the penetration curve 91 was determined. By descendants of the determined penetration curve 91 the milling head 5 can mill out an opening cleanly and reliably from the wall of the reorganization pipe 1 within the range of the annexe 2.

1. Channel milling robot in form of an oblong transportation carriage (41), at whose lower surface (43) wheels (42) are installed and whose opposite top side (45) is provided with an extendable pressure cushion (44) for clamping the transportation carriage (41) in a reorganization pipe (1), also to the back (46) of the transportation carriage (41) following hydraulic and/or pneumatic as well as electrical steering wheels and supply lines, and with linear adjustable and perpendicularly to the longitudinal axis (L) the transportation carriage (41) a swivelling driving out cylinder (48), in the longitudinal axis (L) the transportation carriage (41), at whose front a parallel linkage (49) is linked, which carries a tool holder (50), into which a drive owner (51) with a milling head (5) is inserted, for that over a tap (52) in the tool holder (50) in one level around 180 DEG is swivelling, which perpendicularly to the longitudinal axis of the transportation carriage (41) and concomitantly perpendicularly to the direction of motion of the transportation carriage (41) in the reorganization pipe (1) when radial level runs, whereby for the instrumentation collection of the space coordinates of the not-visible annexes necessary for the free milling at the drive owner (51) additionally a sensor shifts (2) by 180 DEG in the plane of rotation of the milling head (5) and, so that diametrically opposite by the milling head (5) is arranged; and whereby to the positioning of the sensor a combined way/angle measuring system (12) with gating circuit (8) to the driving out cylinder (48) is coupled; by the fact characterized that the sensor is a combination sensor (6), which exhibits a capacitive sensor (61) and a rod-shaped ultrasonic sensor (62); and that the capacitive sensor (61) exhibits circular electrodes (611, 612, 613), the rod-shaped ultrasonic sensor (62) concentrically surround those. 2. Channel milling robot according to requirement 1, marked the outermost electrode (613) by it that the capacitive sensor (61) exhibits three circular electrodes (611, 612, 613), by which is grounded, during to which middle electrode (612) and to the internal electrode (611) in the enterprise the same HF- tension with constant amplitude is put. 3. Channel milling robot according to requirement 1 or 2, by the fact characterized that to the middle and the internal electrode (612, 611) of the capacitive sensor (61) a sum-and-difference amplifier (7) is attached. 4.Kanal-Fraesroboter after one of the requirements 1 to 3, by the fact characterized that to the ultrasonic sensor (62) a measuring amplifier (63) is attached, whose exit is supplied by way of a comparator circuit (69) of a driving circuit (64), which heads for an actuator (65), which serves (69) for the adherence to over the comparator circuit a constant distance ready for input (r) from the combination sensor (6) for the wall of the reorganization pipe (1). 5. Channel milling robots after one of the requirements 1 to 4, by it characterized that the output signal of the measuring amplifier (7) and from the position coordinates of the driving out cylinder (48) in the computer (9) the spatial position of the penetration line (91) between annexe (2) and reorganization pipe (1) is assignable, and that from these instrumentation and computationally determined space coordinates are determinable adjusting signals, which over a control line (92) to the control drive (11) for the driving out cylinder (48) will transfer. 6. Channel milling robot after one of the requirements 1 to 5, by the fact characterized that the driving out cylinder is swivelling (48) by control drives (11) both in longitudinal direction (A) of the transportation carriage (41) movably, and around 360 DEG (C) around the longitudinal direction (A).